

Studies of Cholera El Tor in the Philippines *

3. Transmission of Infection among Household Contacts of Cholera Patients

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As part of a broad epidemiological investigation of cholera El Tor in the Philippines, the authors cultured rectal swabs obtained from the household contacts of cholera patients hospitalized in the Negros Occidental Provincial Hospital from August through October 1962. Additional infected persons were found in 25 (60%) of the 42 households with confirmed cases and in 55 (18%) of 302 household contacts of confirmed patients. Since only five of the 55 infected household contacts developed illness severe enough to require hospitalization, it was apparent that those with severe illness accounted for but a small proportion of the total infections. Asymptomatic infections were rarely found outside the households with proven cases, suggesting that close person-to-person contact was necessary for the spread of infection. Asymptomatic carriers as well as symptomatic patients appeared to play significant roles in the transmission of infection.

The occurrence of cases of cholera El Tor in Negros Occidental Province during an epidemic resurgence from June through September 1962 followed a pattern consistent with person-to-person spread of the disease (Dizon et al., 1965).⁸ Characteristically, the disease occurred in the poorest segments of the population, suggesting that environmental factors such as sanitation, overcrowding, and poor personal hygiene might be significant in the transmission. At the same time, however, from hospital record analyses Dizon et al. reported that in only 3.6% of the households was there more than one case recorded.

Because the closest associations occur within the family group, bacteriological investigations of the household contacts of cholera patients were carried out to ascertain the frequency and pattern of spread of infections among these contacts.

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METHODS

Admissions to the cholera ward of the Negros Occidental Provincial Hospital from 15 August through 3 October 1962 served as the source of the index cases; 166 patients were admitted during this study period. Rectal swabs were obtained from these patients daily during their hospitalization and examined for cholera vibrios.

Within six days of the date of admission to the hospital of the index case, swabs from 452 household contacts of 77 patients, selected primarily on the basis of accessibility, were cultured. In this study, household contacts refer to all persons eating and sleeping in the same dwelling unit as the patient—a dwelling unit generally consisting of a one- to four-room house of nipa palm. The majority of the household contacts were examined before the index

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⁸ See the article on page 627 of this issue.

case had been confirmed bacteriologically as cholera. This resulted in the selection of a number of households with hospitalized gastroenteritis cases of undetermined etiology.

From 97 persons in 13 households, in each of which a bacteriologically confirmed hospitalized cholera case had occurred, rectal swabs were cultured on several occasions at one- to five-day intervals to detect possible additional infections.

Bacteriological methods

Health department personnel collected all specimens for culture from cases and contacts by means of sterile rectal swabs which were immediately placed in alkaline peptone water and submitted to the laboratory identified only by code number. Upon arrival at the laboratory, the specimen was incubated for 6 hours at 37°C, then streaked on to a meat-extract agar (MEA) plate. Peptone water was secondarily inoculated from the original swabs, incubated for 6 hours, and also streaked on to a MEA plate. After incubation overnight, the plates were examined under a stereoscopic dissecting microscope using transmitted oblique illumination (Finkelstein & Gomez, 1963; Lankford, 1959). Suspicious colonies were tested in absorbed cholera antisera specific for O Group 1, Ogawa, and Inaba strains (kindly supplied by Dr Kenneth Goodner, Jefferson Medical College, Philadelphia, Pa., USA). Agglutinable colonies were inoculated into Kligler's iron agar, incubated for 10-12 hours, and then retested in antisera. Of the agglutinable vibrios 98% were of the Ogawa serotype, the remainder Inaba. The cholera vibrios were confirmed as El Tor by the chick red-cell agglutination test (Finkelstein & Murkerjee, 1963). All agglutinable vibrios were in Heiberg Group I (Heiberg, 1934), and were positive by the oxidase and Voges-Proskauer tests (Barritt, 1936).

Non-agglutinable vibrios were obtained from approximately 5% of all individuals whose swabs were cultured. There was no association of these non-agglutinable vibrios with gastrointestinal illness or cholera-like infection.

RESULTS

Ninety-six of the 166 patients hospitalized in the cholera ward during the six-week study period were bacteriologically confirmed as suffering from cholera El Tor. These 96 cases came from 90 households: 84 households had only a single case, while in each of six households there were two cases.

Seventy-seven households were initially selected for culturing. In 42 households the index cases were bacteriologically confirmed as suffering from cholera; in the remaining 35 households, the cholera bacillus was not recovered from the index cases. There were 150 household contacts of the 35 gastroenteritis patients from whom the cholera organism was *not* recovered. Only one yielded a positive culture for cholera El Tor. Interestingly, this infected individual had been hospitalized 25 days previously for a cholera infection; bacteriological investigation, however, had not been done at that time.

In the 42 households with confirmed cholera cases, 302 contacts were examined on a single occasion within six days of the hospitalization of the index case. Positive cultures were obtained from 55 (18%) of the 302 persons in 25 (60%) of the 42 households. Infection rates ranged from 11% to 23% in age-groups over 1 year; among those less than 1 year of age, 7 of 71 (41%) were infected (Table 1).

TABLE 1
INFECTION RATES AMONG HOUSEHOLD CONTACTS
OF CONFIRMED CHOLERA EL TOR PATIENTS
BY AGE-GROUP IN NEGROS OCCIDENTAL,
AUGUST TO OCTOBER 1962

Age-group (years)	No. of index cases	Contacts		
		No. examined	No. infected	Infection rate (%)
<1	—	17	7	41
1-4	3	50	11	22
5-9	4	60	14	23
10-19	3	64	7	11
20-29	7	38	4	11
30-39	7	26	5	19
≥40	15	46	7	15
Age unknown	3	1	—	—
Total	42	302	55	18

Clinical disease, ranging from mild to severe diarrhoea, developed in seven of the 55 infected contacts; five of these seven symptomatic individuals required hospitalization. In three instances, detailed below, positive cultures were obtained from the contacts prior to the onset of symptoms, at intervals of 12, 40 and 96 hours.

Family 1: A 34-year-old man experienced the onset of typical cholera symptoms on 17 August, was hospitalized and was found to be excreting cholera vibrios on 18 August. Cultures obtained on 20 August from his 1-year-old son, 3-year-old son and 22-year-old wife revealed no cholera organisms; a 37-year-old brother was positive by culture. The brother remained asymptomatic until 24 August, approximately 96 hours later, when he developed severe diarrhoea requiring hospitalization. A culture obtained by rectal swab on 24 August confirmed that he was still excreting cholera vibrios.

Family 2: A 22-year-old woman experienced the onset of cholera symptoms on 14 September and was hospitalized. A culture obtained by rectal swab on 15 September revealed cholera vibrios. Cultures from the household on 17 September revealed four asymptomatic carriers: her 4-year-old daughter, her 3-year-old son, her 6-year-old nephew, and her 64-year-old father. Her 35-year-old husband, 2-year-old daughter, and 10 other household members were all found to be negative for cholera vibrios on 17 September. Cultures obtained again on 19 September yielded the same results. However, approximately eight hours before cultures were made from the household on 19 September, the 64-year-old father developed severe diarrhoea requiring hospitalization. Cholera vibrios had been cultured from a rectal swab approximately 40 hours prior to the onset of his symptoms.

Family 3: A 3-year-old boy developed diarrhoea on 1 September, was hospitalized on 2 September, and was found to be excreting cholera organisms. Of the 12 others in the household, four (his 49-year-old father, 18-year-old brother, 4-year-old sister, and 7-year-old brother) were found to be excreting cholera organisms at various times over the next 10 days. The 7-year-old brother was found to be an asymptomatic carrier on 8 September. Approximately 12 hours after the positive culture was obtained on 8 September, he developed severe diarrhoea and was hospitalized on 9 September. A culture obtained on that date was again positive for cholera organisms.

From 13 of the 42 households, cultures were obtained on several occasions at one- to five-day intervals from all available household members. Among the 97 contacts initially examined and followed, 14 were found to be infected on the initial culture. Additional cultures subsequently revealed infections in seven other individuals. These seven persons had negative cultures from two to seven days before a positive culture was obtained. Table 2 shows the results of cultures for cholera vibrios for five of the 13 households repeatedly cultured in which the seven individuals originally negative for cholera vibrios were subsequently found to be infected with the organism.

DISCUSSION

Person-to-person spread of infection among close contacts of cholera patients has been demonstrated to be one mode of transmission of the disease. However, the frequency of contact infection in cholera outbreaks has been the subject of divergent opinions. This is reflected in the extensive review by Pollitzer (1959), who states: "Some consider it a frequent or even the common means of the spread of epidemics, while others assert the rarity of this mode of infection, pointing out in particular that the disease does not usually show a tendency to familial spread; infection in one inhabitant of a house as a rule remaining confined to that person". The infrequency of multiple clinical cases within the same household is illustrated by the studies of Siddhichai & Grayston (1960), Morgan et al. (1960) in Thailand, and Seal (communication to WHO, 1958) in India, where multiple hospitalized cases occurred in less than 5% of the households with cases. In a previous report based on an analysis of hospital records (Dizon et al., 1965),¹ 3.6% of households had multiple hospitalized cases during the two epidemics of cholera El Tor in 1961 and 1962 in Negros Occidental Province.

The present study is in basic agreement regarding the relative rarity of multiple clinical cases in the same household. Only 6.7% of the 90 households with bacteriologically confirmed cases had multiple hospitalized cases. In contrast to this observation, however, bacteriological investigation of 42 households with confirmed cases revealed one or more additional infected individuals in 25 households (60%). Further, while the secondary attack rate for hospitalized cases among the 302 household contacts studied was only 1.6%, the infection rate determined by a single culture was 18.2%. It can thus be reasonably estimated that in this outbreak the infection rate was approximately 10 times higher than the attack rate for clinically severe cholera among household contacts.

While most of the infected household contacts probably acquired their infections from the patient constituting the index case prior to his hospitalization, the role of asymptomatic carriers in transmission of infection is suggested by the results of the serial studies in 13 households. These studies turned up seven contacts, initially bacteriologically negative, who appeared to acquire their infections after the index case had been hospitalized. All seven lived in

¹ See the article on page 627 of this issue.

TABLE 2
CULTURE RESULTS FROM FIVE HOUSEHOLDS IN WHICH PERSONS ORIGINALLY NEGATIVE
FOR CHOLERA VIBRIOS SUBSEQUENTLY BECAME POSITIVE

Household 4
Index case: 24-year old male; onset of illness,
21 Aug.; hospitalized 24 Aug.

Age and sex of household member	Date of culture		
	28 Aug.	1 Sept.	8 Sept.
49 M	-		-
27 M	-		-
25 M	-	-	-
17 F	-	-	-
45 F	-	-	-
2 F	-		-
5 F	+	-	-
12 M	-	-	-
3 F	-	-	-
19 M	+	+	-
10 F	-	-	-
8 F ^a	-	+	-

^a Originally negative; subsequently positive.

Household 1
Index case: 3-year-old male; onset of illness, 1 Sept.;
hospitalized, 2 Sept.

Age and sex of household member	Date of culture					
	3 Sept.	5 Sept.	8 Sept.	9 Sept.	10 Sept.	13 Sept.
49 M		+	+	+	+	-
38 F	-	-	-	-	-	-
30 F		-	-	-	-	-
18 M ^a	-				+	-
15 M	-		-	-	-	-
11 M	-			-	-	-
10 F	-		-	-	-	-
9 M			-	-	-	-
7 M ^a	-		+	+ ^b		
4 F	+	+ ^c				
4 M	-		-	-	-	-
1 M	-		-	-	-	-
1 F	-		-	-	-	-

^a Originally negative; subsequently positive.

^b Hospitalized on 9 Sept. as cholera patient.

^c Hospitalized on 5 Sept. for carrier study.

Household 5
Index case: 33-year-old female; onset of illness,
10 Sept.; hospitalized 11 Sept.

Age and sex of household member	Date of culture			
	12 Sept.	14 Sept.	15 Sept.	17 Sept.
67 M	-	-	-	
26 F	+	+	+	-
19 F	-		-	-
18 F		-	-	-
15 F	+	+	-	-
5 F	+	+	+	-
4 F ^a	-	-	-	+
2 F	-	-	-	-
¹ / ₁₂ F		+	-	-

^a Originally negative; subsequently positive.

Household 7
Index case: female; onset of illness
and hospitalized, 13 Sept.

Age and sex of household member	Date of culture		
	15 Sept.	17 Sept.	19 Sept.
65 M		+	-
40 F ^a	-	+	+
23 F		-	
22 M		-	
¹ / ₁₂ F ^a	-	+	

^a Originally negative; subsequently positive.

Household 12
Index case: 17-year-old female;
onset of illness and
hospitalized, 14 Sept.

Age and sex of household member	Date of culture	
	15 Sept.	19 Sept.
64 M	-	-
32 M	-	
15 M ^a	-	+
11 M	-	
7 M	-	-
4 M	-	
3 F	-	-
¹ / ₁₂ M	+	+

^a Originally negative; subsequently positive.

a household with another asymptomatic carrier. Furthermore, the fact that some remained uninfected for as long as seven days after the onset of illness of the index case suggests the role of asymptomatic carriers in explaining the interval occasionally found between cases within a household.

The high infection rates in the age-group under 1 year and in the younger children are of particular interest. Dizon et al. (1965) have shown that, based on both morbidity and mortality studies, cholera in Negros Occidental was characteristically a disease of adults over the age of 20. In fact, none of the 96 confirmed cholera patients in the present study was under the age of 1 year. When this high infection

rate among children is contrasted with the higher clinical attack rate among adults, it suggests that additional factors, more common in adults, predispose to the manifestation or recognition of the disease.

In three individuals, cholera vibrios were isolated approximately 12, 40 and 96 hours before onset of cholera symptoms requiring hospitalization. Although it is possible that the symptoms requiring hospitalization were caused by organisms or illnesses other than cholera, it would seem more likely that these individuals were cholera victims in the incubation stage of the disease at the time of the original positive culture.

RÉSUMÉ

Dans deux articles précédents, les auteurs ont exposé les caractères généraux du choléra El Tor dans la République des Philippines, puis le caractère explosif de la première épidémie dont les cas apparurent après consommation de crevettes crues. Ils étudient ici les résultats des cultures à partir des prélèvements rectaux pratiqués sur des contacts familiaux de malades hospitalisés d'août à octobre 1962, au cours de la seconde épidémie. Sur 42 familles de malades confirmés, 25 (60%) comptaient des personnes infectées, et sur 302 contacts de ces cas avérés, 55 (18%) étaient infectés. Cinq seulement de ces contacts infectés présentèrent une maladie sévère. Il fut impossible d'isoler un vibriion cholérique de certains

malades hospitalisés pour diarrhée et chez 150 contacts familiaux de tels malades, l'infection ne fut trouvée qu'une fois (0,7%).

Dans 13 familles de cas bactériologiquement confirmés de choléra, 97 personnes furent examinées: 14 étaient infectées dès la première culture, et 7 furent trouvées infectées en répétant les examens. Dans ces 7 cas, un autre porteur asymptotique avait transmis l'infection.

Les observations font conclure à l'importance de la transmission du choléra par contact de personne à personne et suggèrent que les porteurs asymptotiques y jouent un rôle aussi important que celui des cas symptomatiques.

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